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(54) Title: METHOD FOR TREATMENT OF INVASIVE CELLS (57) Abstract A method for treating metastatic tumor cells of a subject is disclosed. The method comprises administering to the subject an antisense molecule comprising a nucleotide sequence which is complementary to an RNA sequence of a protease activated receptor (PAR) protein, or an antibody molecule capable of binding to a PAR protein. A method is also described for the treatment of disorders involving the implantation of a placenta in a female subject comprising administering to the subject the antisense molecule. Also disclosed is the antisense molecule and a pharmaceutical composition comprising it.		

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METHOD FOR TREATMENT OF INVASIVE CELLS

FIELD OF THE INVENTION

This invention relates to the therapeutic use of molecules associated with protease activated receptors.

BACKGROUND OF THE INVENTION

5 References referred to by bracketed numbers in the body of the specification are listed at the end of the specification before the claims.

The process by which epithelial cells become invasive is complex and has yet to be fully elucidated. One example of this process is observed in metastatic tumors. Another example of epithelial cells becoming invasive occurs
10 during normal human embryonic development, in which the cytotrophoblasts (i.e. the fetal cells on the front line of the placenta) invade the uterus, as part of their normal differentiation program and successful implantation.

The physiologic invasiveness of cytotrophoblasts closely resembles that of malignant cells, sharing many common features. Tumor invasion and
15 metastasis involve, among other alterations, proteolytic modification of basement membranes and extracellular matrices (ECMs). Cancer cells have to detach from their primary location, encounter basement membranes (i.e. during extravasation of blood or lymphatic vessels), and disseminate through the circulation to establish new cellular colonies at distant sites. Therefore, the
20 process of cell invasion involves a well-orchestrated sequence of events including integrin activation, cell migration and proteolytic degradation of specific barrier components. This enzymatic cleavage is highly regulated, since extensive proteolysis could impede the invasive process by degrading essential

matrix components required for the transmission of survival and cell shape signals, through contacts with the basement membrane. Localized proteolysis directed to discrete regions of the cell surface may facilitate cellular invasion.

The thrombin-receptor (ThR) is a seven transmembrane domain
5 G-coupled protein, belonging to the protease-activated receptor (PAR) family [1]. Recently, two other members of this family (PAR-2 and PAR-3) have been identified [2-4], and a fourth member (PAR-4) has also been described [19]. Unlike most cellular growth factor receptors, the activation of these receptors does not require formation of the traditional ligand-receptor complex. Instead,
10 the receptor serves as a substrate for proteolytic digestion, yielding an irreversible form of activated cell surface protein to convey further cell signaling.

Applicant's co-pending Israel Patent Application No. 114890, whose contents are incorporated herein by reference, discloses that a direct correlation
15 exists between ThR level of expression in tumor cells and their degree of invasiveness. This finding was used to develop a diagnostic method for evaluating the metastatic tendency of tumor cells by following the expression of the ThR gene.

U.S. 5,352,664 to Carney, *et al*, describes thrombin-derived polypeptides
20 which are capable of selectively stimulating or inhibiting thrombin receptor occupancy signals. Carney suggests that the inhibitory polypeptides may be used in preventing metastasis and angiogenesis. No supporting data is disclosed.

SUMMARY OF THE INVENTION

25 It is an object of the present invention to provide a method for treating metastatic tumors.

It is a further object of the present invention to provide a method for treating irregularities in physiological placental development.

The present invention is based on the surprising finding that interfering with the expression of PAR proteins of an invasive cell affects its degree of invasiveness. The interference may be realized at the DNA (gene) level, at the mRNA level, and/or at the protein (receptor) level. Interference at the DNA level
5 may be achieved by use of gene therapy methods; interference at the mRNA level may be achieved by use of antisense molecules; and interference at the protein level may be achieved by use of specific antibodies.

The PAR protein may be any member of the PAR family such as, for example but not limited to, ThR, PAR-2, PAR-3 and PAR-4.

10 In a first aspect of the invention, the invasive cells are pathological cells such as metastatic tumor cells. Thus, in this aspect of the invention, there is provided a method for treating metastatic tumor cells of a subject comprising administering to said subject an antisense molecule, said antisense molecule comprising a nucleotide sequence which is complementary to an RNA sequence
15 of a PAR protein.

Also provided are antisense molecules and pharmaceutical compositions comprising them.

Further provided is a method for treating metastatic tumor cells of a subject comprising administering to said subject an antibody molecule, said antibody
20 molecule being capable of binding to a protease activated receptor (PAR) protein. The antibody molecule may be a polyclonal or monoclonal antibody, prepared by methods known *per se*.

In this aspect of the invention, the tumor cells will generally be of epithelial origin, which form solid carcinoma-type tumors. Examples of such epithelial
25 tissues are breast, esophagus, kidney, prostate, ovary, melanoma and bladder tissue.

In a second aspect of the invention, the invasive cells are normal cells such as placental cells. As described above, ThR plays a role during cytotrophoblast invasion and implantation. The finding that ThR expression is
30 associated with the invasiveness of placental tissue may be beneficial for

improved implantation of human embryo in the maternal uterus decidua. To date, the rate of spontaneous abortions is 8-12%, 50% of which are due to defects in proper implantation. It is even more striking in the I.V.F. procedure, where 40% of the overall cases result in failure. 90% of these failures are
5 apparently due to implantation defects. Transfection of normal placenta with ThR and other PAR family genes may considerably improve implantation.

Thus, in this aspect of the invention, there is provided a method for the treatment of disorders involving the implantation of a placenta in a female subject comprising administering to said subject an antisense molecule, said antisense
10 molecule comprising a nucleotide sequence which is complementary to an RNA sequence of a PAR protein.

Also provided are antisense molecules and pharmaceutical compositions comprising them.

The synthesis of antisense molecules to known mRNA sequences is well
15 known to the skilled artisan. In theory, based on Watson-Crick base pair formation, if an appropriate target can be identified, an antisense oligomer of more than 15 to 17 nucleotides in length would be expected to have a unique sequence relative to the entire human genome. A suitable oligomer should be able to interfere, in a sequence specific manner with the process of mRNA
20 translation into protein [9]. The requirements for an antisense oligomer for therapeutic use are: (1) that it must be stable *in vivo*; (2) it must be able to enter the target cell; and (3) it must be able to interact with its cellular targets.

As oligomers possess little or no innate ability to diffuse across cell membranes, the cells must take them up through energy-dependent mechanisms.
25 To resolve the problem of uptake, a large number of strategies have been employed in order to augment the rate of cellular internalization of nucleic acids and to increase the rate at which they pass through the endosomal membrane. These strategies include: (i) coupling oligomers to polycations such as polylysine [10], polyethylamine [11] or others; (ii) use of
30 transferrin/polylysine-conjugated DNA in the presence of the capsid of a

replication-deficient adenovirus [12]; (iii) conjugation of oligonucleotides to fusogenic peptides [13] or to a peptide fragment of the homeodomain of the *Drosophila* antennapedia protein [14]; (iv) targeting of oligonucleotides to specific cell surface receptors, such as folate, asialoglycoprotein receptor and transferrin [15], (v) conjugation to cholesterol [16]; and, most successfully (vi) complexation of oligonucleotides with cationic lipids [17] and GS 288 etofectin [18].

Preferred antisense sequences are those designed to comprise sequences which hybridize to uniquely conserved regions in the PAR family of proteins. Conserved regions may be identified by comparing the nucleotide sequences of different members of the PAR family. For example, certain regions within the ThR sequence have 27% sequence similarity to PAR-3 and 28% similarity to PAR-2. Examples of conserved unique regions are:

1) The protease activated domains and hirudin binding domain:

15

Nucleotides

hPAR-1(ThR)	37-61..... TLDPRS <u>FLLRN</u> PNDK <u>YEPF</u> WEDEEK
hPAR-2	32-56.....SSKGR <u>SLIGK</u> VDGTSHVTGKGVTVE
hPAR-3	34-57.....TLPIK <u>TFRG</u> APPN <u>SFE</u> FPFSALE
hPAR-4	28-52.....LPAPRG <u>YPGQ</u> VCANDSDTHELPDSS

2) Second extracellular loop: located between transmembrane domains 4 & 5 and corresponding to residues: **ITTCHDV** which are conserved in PAR 1-3, while in PAR-4 only the three amino acids **CHD** are conserved.

3) The entire promoter region of the PAR family (i.e. 5' cloned regions downstream to the ATG of PAR-1 and PAR-3). This region is likely to contain important regulatory sequences.

DETAILED DESCRIPTION OF THE DRAWINGS:

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 shows the DNA and amino acid sequence of human ThR [1];

Fig. 2 shows the DNA sequence of an antisense cDNA of ThR;

Fig. 3 shows the location of the ThR antisense in the pcDNA III vector;

Fig. 4 illustrates ThR expression in human breast carcinoma cell lines.

5 Total RNA isolated from human breast carcinoma cell-lines was analyzed by Northern blotting. The cell lines used were: MDA-435 (A), MDA-231 (B) and MCF-7 (C), as well as Ha-ras-transfected breast carcinoma cell lines, MCF10AT3B (D), MCF10AT (E) and MCF10A (F). The blots were probed with ^{32}P -labeled 250 base pair DNA, corresponding to ThR (upper part), or
10 with ^{32}P -labeled β -actin DNA (lower part).

Fig. 5 illustrates immunocytochemical analysis of cell-associated ThR. Human breast carcinoma cell lines (MCF-7, MDA-231, and MDA-435) were cultured in 8-well chamber slides and analyzed for the presence of ThR. Specific staining of the receptor was obtained following incubation with affinity
15 purified polyclonal anti ThR antiserum followed by biotin conjugated goat-anti-rabbit IgG antibodies and detected by extravidin incubation. Photographs of representative areas of MCF-7 (a), MDA-231 (b) and MDA-435 (c) cell monolayers are shown (x400).

Lower Panel. Western blot analysis of ThR. Western blot analysis of cell
20 lysates (50 μg /lane) of MCF-7 (A), MDA-231(B) and MDA-435 (C) cells. Specific protein band was detected following incubation with anti ThR antibodies and visualized by the ECL immunoblotting detection system according to the manufacturer's instructions.

Fig. 6 illustrates *in situ* hybridization of ThR mRNA in normal and
25 cancerous breast tissue specimens. Hybridization with ThR riboprobes was performed on: Normal breast duct lobular units (A&D). Invasive duct carcinoma, (IDC) (antisense orientation, C; sense orientation, B). High grade DCIS of comedo type (antisense orientation, E; sense orientation, F). Low grade DCIS, solid type (G) and atypical intraductal hyperplasia (AIDH, H & I).

Detection of specifically hybridized mRNA to DIG-labeled probe was performed using anti-DIG-alkaline phosphatase conjugated antibodies (Boehringer Mannheim, Mannheim, Germany). These analyses represent at least 3 patients of each category.

5 **Fig. 7** illustrates Matrigel invasion of breast carcinoma cell lines. The indicated cells (ZR-75, A; MCF-7, B; MDA-435, C; MDA-231, D; fibrocystic MCF10AT3B, E; fibrocystic MCF10A, F) were applied (2×10^5 cells/assay) to the upper compartment of Boyden chambers. Cell invasion through Matrigel coated filters was determined, as outlined in Materials and Methods, below.

10 **Fig. 8** illustrates inhibition of MDA-435 Matrigel invasion by ThR antisense. MDA-435 cells were transiently transfected with pCDNAIII expression plasmid containing the antisense ThR of Fig. 2. The level of invasion was compared to untreated MDA-435 (A) and MCF-7 (B) cells. Control transfections of MDA-435 cells were performed in the presence of vector alone
15 - (C) or DOTAP liposomes alone (Gibco -BRL) (D). Nearly confluent (60%) cells were treated with various concentrations of the plasmid: transfection with antisense ThR - 5 μ g/plate (E), transfection with antisense ThR - 20 μ g/plate (F). The invasion assay was performed as described under Materials and Methods, 72 h following transfection.

20 **Lower panel.** Western blot analysis of ThR antisense transfectants. MDA-435 cell lysates (50 μ g/lane) of ThR antisense transfectants (A) were applied on SDS-PAGE and the level of receptor protein was compared to cells transfected with vector alone (B) or untreated cells (C).

Fig. 9 shows the DNA sequence of PAR-2;

25 **Fig. 10** shows the DNA sequence of PAR-3;

Fig. 11 shows the DNA sequence of PAR-4; and

Fig. 12 illustrates expression of ThR in first trimester human placenta. *In situ* hybridization analysis of ThR expression at 6-15 weeks of gestation. Placental tissue was obtained from elective termination of pregnancies by
30 dilatation and curettage. Sections of 6 week placental tissue (A) and of 7, 8, 9

and 10 weeks of gestation (B-E, respectively), as visualized by ThR staining of cytotrophoblasts. No staining was observed at weeks 11 and 15 (F & G, respectively). Control hybridization (weeks 7 and 8) using sense orientation showed background staining (H & I, respectively).

5

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Materials and Methods

Cells: The human breast carcinoma cell lines, MCF-7 (adenocarcinoma), MDA-MB-231 (adenocarcinoma), MDA-MB-435 (ductal carcinoma) and
10 ZR-75-1 (carcinoma), were kindly provided by Dr. Robert Stern (Department of Pathology, University of California, San Francisco). The invasive properties of these breast cell lines were determined following injection of the cells into the mammary pads of nude mice with or without Matrigel [5]. Cells were cultured in DMEM (1g glucose/liter) containing 10% bovine calf serum. MCF10A
15 (nearly-normal immortalized epithelial cells), MCF10AT cells (derived from human fibrocystic epithelium transfected with Ha-ras) and MCF10AT3B cells (derived from a 94-day third transplant generation of lesion in Beige /Nude mice, classified as grade 2), were kindly provided by Dr. F. R. Miller (Karamanos Cancer Institute, Meyer L. Prentiss Center, Detroit) and grown in
20 RPMI-1640 containing 10% fetal calf serum (FCS). Tissue culture medium was supplemented with penicillin (50 U/ml) and streptomycin (50 µg/ml) (GIBCO-BRL, Gaithersburg, MD) and the cells were maintained at 37°C in a 10% CO₂ humidified incubator. Cells were dissociated with 0.05% trypsin/0.02% EDTA, 0.01M sodium phosphate (pH 7.4) solution (STV) and
25 subcultured at a split ratio of 1:5.

Plasmids and transfection: The DNA and amino acid sequences of ThR are shown in Fig. 1 [1]. ThR in the antisense orientation (Fig. 2), consisting of 612 nucleotides (from (-)75 to (+)537 of Fig. 1) was prepared and inserted into the

eukaryotic expression plasmid, pcDNA III (Invitrogene, Carlsbad, CA) at the HindIII and EcoRI sites (Fig. 3). Antisense ThR cDNA was used for transient transfection experiments. Subconfluent (25-40%) MDA-435 breast cancer cells were grown in 60 mm culture dishes and a total of 5-20 µg of DNA and
5 DOTAP - transfection reagent (10 µg DOTAP/µg DNA; 4.5 h incubation, Boehringer Mannheim, Mannheim, Germany) were used for transfection. Cells were assayed 48-72 h following transfection.

RNA Isolation and Northern blot analysis: RNA was prepared using
10 TRI-Reagent (Molecular Research Center, Inc. Cincinnati) according to manufacturer's instructions. The RNA (20 µg of total RNA) was separated by electrophoresis through a 1.1% agarose gel containing 2 M formaldehyde, transferred to a nylon membrane (Hybond N⁺; Amersham) and hybridized either to cDNA probes or PCR product radiolabeled by random primer extension with
15 [α -³²P]dCT [6] for 24 h at 42°C. The membrane was washed twice for 30 min at room temperature with 2x SSC containing 2% SDS and 15 min at 50°C with 0.1x SSC, containing 0.1% SDS. The blots were exposed for 2-4 d at -70°C and the relative amounts of mRNA transcripts were analyzed by laser densitometry using an Ultrosan XL Enhanced Laser Densitometer and normalized relative to
20 internal β -actin controls.

In situ hybridization of human tumor and placenta biopsy specimens. RNA probes were transcribed and labeled by T₇ RNA polymerase (for antisense orientation) or T₃ RNA polymerase (for sense control orientation) using
25 DIG-UTP labeling mix (Boehringer Mannheim, Mannheim, Germany). Probes were labeled from plasmid containing 462 base pair fragments of the human ThR (pBhThR-462S) inserted into the EcoRI-HindIII site. Final concentration for hybridization was 1 µg/ml, according to the manufacturer's instructions for non radioactive *in situ* hybridization application. Hybridization was carried out

(overnight, 45°C) on paraffin embedded breast tissue sections (Department of Pathology, Hadassah University Hospital, Jerusalem) or placenta sequential sections. Slides were washed in 0.2xSSPE (3x 1 h) at 50°C and blocked by blocking reagent (Boehringer Mannheim, Mannheim, Germany). Detection was performed using AP-conjugated, anti-DIG antibodies (Fab-fragment, diluted 1:300; 5
Boehringer Mannheim, Mannheim, Germany), overnight at room temperature. AP reaction was detected by NBT/BCIP reagents according to the manufacturer's instructions.

10 **Immunohistochemistry:** Tumor cells were cultured overnight at 37°C on eight chamber slides. The cells were fixed with 2% formaldehyde and 2% sucrose/PBS at room temperature for 30 min and permeabilized with 20 mM Hepes, pH 7.4, 300 mM sucrose, 50 mM NaCl, 3 mM MgCl₂ and 0.5% Triton X-100, for 4 min at 0°C. After rehydration with PBS, the cells were incubated
15 (10 min, 24°C) with 3% H₂O₂ in PBS containing 10 mM glycine, 10 mg/ml BSA, followed by 30 min blocking with normal goat serum in PBS containing 1% BSA. Affinity purified rabbit-anti-human ThR antibodies were added (dilution 1:50-1:200) for 4 h at 4°C, followed by incubation (1 h, room temperature) with a second antibody goat-anti-rabbit IgG-Biotin conjugated and
20 1 h incubation with HRP-ExtraAvidin (1:200) (Sigma Immuno Chemicals, St. Louis, MO).

Antibodies: We have raised anti-ThR antibodies directed toward a synthetic peptide (thrombin- receptor activating peptide; TRAP) corresponding to
25 residues Ser42-Lys51 (i.e. S-F-L-L-R-N-P-N-D-K). KLH conjugated peptide was injected to rabbits, and the immune serum was affinity purified. ELISA was performed on plates coated with the TRAP-peptide showing efficient positive identification at 1:25,600 dilution. Maximal response was obtained at 1:3,200

dilution. Monoclonal anti ThR Abs (mouse IgG1 clone IIaR-A) were used for Western blot analysis (Biodesign, ME, USA)

Western blotting analysis: Cells were dissolved in lysis buffer containing 10 mM Tris-HCl, pH 7.4, 150 mM NaCl, 1 mM EDTA, 1% Triton X-100 and protease inhibitors (5 µg/ml aprotinin, 1µM phenylmethylsulfonylfluoride and 10 µg/ml leupeptin) for 30 min at 4°C. After centrifugation at 10,000 g for 20 min at 4°C, the supernatants were transferred and the protein content was measured. Lysates (50 µg) were loaded and resolved on 10% SDS-PAGE followed by transfer to Immobilon-P membrane (Millipore, MA). Membranes were blocked and probed with anti-ThR antibodies (1:4000) in 1% BSA in 10 mM Tris-HCl (pH 7.5), 100 mM NaCl and 0.05% Tween-20). After washes, blots were incubated with the appropriate second antibodies and conjugated to horseradish peroxidase. Immunoreactive bands were detected by the enhanced chemiluminescence (ECL) reagent using luminol and p-cumaric acid (Sigma, St. Louis, Mo).

Placental tissue sections: Sections of placental tissue, 6-15 weeks of gestation, were obtained from elective termination of normal pregnancies by dilatation and curettage.

Matrigel invasion assay: Blind well chemotaxis chambers with 13 mm diameter filters were used for this assay. Polyvinylpyrrolidone-free polycarbonate filters, 8 µm pore size (Costar Scientific Co., Cambridge, MA), were coated with basement membrane Matrigel (25 µg/filter) as previously described [7]. Briefly, the Matrigel was diluted to the desired final concentration with cold, distilled water, applied to the filters, dried under a hood, and reconstituted with serum-free medium. Cells ($2-3 \times 10^5$), suspended in DMEM containing 0.1% bovine serum albumin were added to the upper chamber.

Conditioned medium of 3T3 fibroblasts was applied as a chemoattractant and placed in the lower compartment of the Boyden chamber. Assays were carried out at 37°C in 5% CO₂. Over 90% of the cells attached to the filter after a 2h incubation. At the end of the incubation, the cells on the upper surface of the filter were removed by wiping with a cotton swab. The filters were fixed in methanol and stained with hematoxylin and eosin. Cells in various areas of the lower surface were counted and each assay was performed in triplicate. For chemotaxis studies, filters were coated with collagen type IV alone (5µg/filter) to promote cell adhesion. Cells were added to the upper chamber and conditioned medium was applied to the lower compartment.

Examples

Example I: ThR expression in breast carcinoma cell lines.

In a preliminary experiment, a panel of mammary carcinoma cells was surveyed for a possible correlation between the level of ThR expression and established degrees of metastasis (Fig. 4). The cell lines used included one near-normal diploid immortalized breast epithelial cell line (MCF10A) originating from fibrocystic disease, and 6 tumor cell lines exhibiting different doubling times, tumorigenicity and metastases in nude mice. Of these cell lines, MDA-435 (a highly metastatic cell line), and MCF10AT3B (ras transfected fibrocystic epithelium re-established several times from lesions formed in nude mice), were compared to medium metastatic (MDA-231 and MCF10AT, ras transfected fibrocystic cells), or carcinoma cells exhibiting no metastatic potential (ZR-75 and MCF-7 cells). As shown in Fig. 4, high levels of ThR mRNA were found in the highly aggressive cells (lanes A, D) as compared to moderate levels in MDA-231 and ras transfected fibrocystic cells (lanes B& E, respectively), and no expression in the non-metastatic MCF-7 and MCF10AT cells (lanes C&F, respectively). The mRNA levels were quantified by densitometric analysis and the ratio of ThR/β-actin in each lane was calculated. The ThR mRNA level in MDA-435 was 6 fold higher than in MDA-231 cells

(Fig. 4, lanes A vs B) and, as mentioned above, no detectable ThR was observed in MCF-7 cells (Fig. 4, lane C). A similar correlation between ThR level of expression and metastasis was obtained in Ha-ras transfected cells showing a 4 fold higher level in MCF10AT3B (obtained following ras-transfection and xenografting 3 times in mice) than in MCF10AT-ras transfected cells (Fig. 4, lanes D vs E). No detectable level of expression was observed in the fibrocystic, non-malignant, epithelial cells, MCF10A epithelial cells (Fig. 4, lane F).

Affinity purified rabbit-anti-human ThR antibodies were applied to detect the expression and localization of the receptor protein. Massive staining of MDA-231 and MDA-435 cells was observed (Fig. 5B&C, respectively), as opposed to little or no staining of MCF-7 cells (Fig. 5A). In parallel, Western blot analysis showed a distinct protein band of ThR in MDA-435 cells (Fig. 5, lower panel; lane C), somewhat reduced ThR level in MDA-231 (lower panel; lane B) and little or no protein in MCF-7 breast carcinoma cells (lower panel; lane A).

Collectively, these data demonstrate the preferential expression of ThR in metastatic breast carcinoma cell lines, but not in non-metastatic MCF-7 or MCF10A breast carcinoma cells, regardless of whether the mRNA or protein levels were evaluated.

Example 2: ThR expression in human breast tissue specimens.

ThR gene expression and localization *in vivo* was studied in formalin fixed paraffin embedded human breast carcinoma specimens as compared to normal mammary sections obtained from reduction mammoplasty. ThR expression was examined in primary breast tumors representing poor to benign prognosis. *In situ* hybridization analysis using a ThR RNA probe (corresponding to nucleotide nos. 320-570 of the sequence of Fig. 1) was performed with an archival set of paraffin embedded biopsy specimens. A total of 10 normal breast tissue specimens, and 8 specimens of infiltrating ductal carcinoma were analyzed. The invasive carcinoma specimens were selected

from typical infiltrating duct carcinoma of high nuclear grade with numerous atypical mitotic figures and with evidence of vascular invasion and lymph node metastases.

As demonstrated in Fig. 6, hybridization of a ThR antisense RNA probe to invasive duct carcinoma specimens resulted in strong positive staining localized specifically to the carcinoma cells (Fig. 6C). Weaker positive staining was noted in high-grade ductal carcinoma *in situ* (DCIS) of comedo-type (Fig. 6 E&F). In contrast, very little or no staining was observed in low-grade, solid type DCIS (Fig. 6G), and no staining was observed in premalignant atypical intraductal hyperplasia (AIDH) (Fig. 6 H&I) and in normal breast duct lobular units (Fig. 6 A&D; note that the high staining seen in the background is limited to the fibers, and is not seen in the epithelial cells). AIDH was distinguished from low grade DCIS, non-comedo type according to the diagnostic criteria of Dupont, Page and Rogers [8]. Expression was also noted in some cases of DCIS, in particular, high grade, comedo-type lesions. The low grade DCIS of solid type showed weak to no expression of ThR, while cases of AIDH, as well as normal breast tissue from reduction mammoplasty specimens did not show any expression of ThR.

Example 3: Antisense ThR inhibits metastatic breast carcinoma cell invasion.

To assess the invasion properties of aggressively metastatic breast carcinoma cells, the Matrigel *in vitro* invasion assay was applied. For this purpose, a reconstituted matrix of basement membrane was utilized to coat porous filters, in order to closely mimic natural barriers in a Boyden chamber. As a chemoattractant source, fibroblast conditioned medium was placed in the lower compartment [7]. The Matrigel invasion assay confirmed the expected differential metastatic properties of the carcinoma cell lines. High levels of invasion through Matrigel were obtained with MDA-435 and MDA-231 cells (Fig. 7, D&C). MCF10AT3B-ras transfected fibrocystic cells invaded the

Matrigel to a lower extent (Fig. 7, E), while no movement was detected with the MCF10AT, MCF-7, or ZR-75 non-metastatic cell lines (Fig. 7, F & A, B, respectively).

To analyze the impact of reduced ThR expression in the highly metastatic cells, MDA-435 breast carcinoma cells were transfected with an antisense ThR cDNA. mammalian expression vector containing ThR cDNA in an antisense orientation under the control of the Cytomegalovirus (CMV) promoter (see Figs. 2 and 3). The vector alone was used as a control. Western blot analysis of ThR protein levels showed a marked reduction in the antisense transfected cells (Fig. 8, lane A) as compared to vector alone (lane B) or untreated MDA-435 cells (lane C). When the antisense transfected cells were tested in the Matrigel invasion assay, the otherwise aggressively invading cells showed a markedly reduced level of invasion, similar to that of the non-metastatic breast carcinoma cell line MCF-7 (Fig. 8, E&F). Transfection with the vector alone had no effect on the invasion properties and the transfected cells migrated effectively through the Matrigel layer (D), similar to the metastatic MDA-435 cells (A).

Similar antisense molecules may be prepared from other members of the PAR family, such as PAR-2 (Fig. 9), PAR-3 (Fig. 10) and PAR-4 (Fig. 11).

Example 4: ThR expression during placenta development.

Human embryo development depends on proper placentation and successful implantation. Trophoblast invasion through the uterine epithelium and deep into the stroma enables the establishment of the proper fetal-maternal interactions. Histological examination of placental biopsies during the first trimester (6-15 weeks), obtained from elective termination of pregnancies, showed a striking pattern of ThR temporal regulation. ThR mRNA levels were not detected up to 6 weeks of gestation (Fig. 12,A), increased markedly between 7-10 weeks (B-E), then fell precipitously at 11 weeks and thereafter (F&G). The staining was specific to ThR, since hybridization with ThR sense

orientation on placental biopsies taken on weeks 7 and 8, showed no staining (H&I, respectively). The receptor appeared localized to the cytotrophoblasts within the villi, and also, to some extent, in the syncytiotrophoblasts of the invading column.

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CLAIMS:

1. A method for treating metastatic tumor cells of a subject comprising administering to said subject an antisense molecule, said antisense molecule comprising a nucleotide sequence which is complementary to an RNA sequence
5 of a protease activated receptor (PAR) protein.
2. A method according to claim 1 wherein said PAR protein is a thrombin receptor.
3. A method according to claim 1 wherein said PAR protein is selected from the group consisting of PAR-2, PAR-3 and PAR-4.
- 10 4. A method according to claim 1 wherein said tumor cell is of epithelial tissue origin.
5. A method according to claim 4 wherein said epithelial tissue is selected from the group consisting of breast, esophagus, kidney, prostate, ovary, melanoma and bladder.
- 15 6. A method according to claim 1 wherein said antisense molecule has the sequence appearing in Fig. 2.
7. A method for treating metastatic tumor cells of a subject comprising administering to said subject an antibody molecule, said antibody molecule being capable of binding to a protease activated receptor (PAR) protein.
- 20 8. A method according to claim 7 wherein said antibody binds an extracellular epitope of said PAR protein.
9. An antisense molecule comprising a nucleotide sequence which is complementary to an RNA sequence of a protease activated receptor (PAR) protein.
- 25 10. A pharmaceutical composition comprising an active factor and a pharmaceutically acceptable carrier, said active factor being an antisense molecule comprising a nucleotide sequence which is complementary to an RNA sequence of a protease activated receptor (PAR) protein.

11. A pharmaceutical composition according to claim 10 for the treatment of metastatic tumor cells.

12. A pharmaceutical composition according to claim 11 wherein said PAR protein is a thrombin receptor.

5 13. A pharmaceutical composition according to claim 11 wherein said PAR protein is selected from the group consisting of PAR-2, PAR-3 and PAR-4.

14. A pharmaceutical composition according to claim 11 wherein said tumor cell is of epithelial tissue origin.

10 15. A pharmaceutical composition according to claim 14 wherein said epithelial tissue is selected from the group consisting of breast, esophagus, kidney, prostate, ovary, melanoma and bladder.

16. A pharmaceutical composition according to claim 10 wherein said antisense molecule has the sequence appearing in Fig. 2.

15 17. A method for the treatment of disorders involving the implantation of a placenta in a female subject comprising administering to said subject an antisense molecule, said antisense molecule comprising a nucleotide sequence which is complementary to an RNA sequence of a protease activated receptor (PAR) protein.

20 18. A method according to claim 18 wherein said antisense molecule is administered to a trophoblast cell.

19. A pharmaceutical composition according to claim 10 for the treatment of disorders involving the implantation of a placenta in a female subject.

```

1  gcgcccgcgc gaccgcgcgc ccagttcccg cccgcccccg ctaaccgccc cagacacagc
61  gctcgccgag gtcgcttg accctgatct taccgtggg caccctgcgc tctgcctgcc
121  gcgaagaccg gctccccgac ccgcagaagt caggagagag ggtgaagcgg agcagcccga
181  ggcggggcag cctcccgag cagcgccgag cagagccccg gacaatgggg ccgcgcgccg
241  tgctgctggt ggccgcctgc ttcagtttgt gcggccccgt gttgtctgcc cgcacccggg
301  cccgcaggcc agaatcaaaa gcaacaaatg ccaccttaga tccccggtca tttcttctca
361  ggaaccccaa tgataaatat gaaccatttt gggaggatga ggagaaaaat gaaagtgggt
421  taactgaata cagattagtc tccatcaata aaagcagtc ctttcaaaa caacttcctg
481  cattcatctc agaagatgcc tccggatat tgcaggctc ctggctgaca ctctttgtcc
541  catctgtgta caccggagt tttgtagtca gcctcccact aaacatcatg gccatcgtg
601  tgttcatcct gaaatgaag gtcaagaagc cggcggtggt gtacatgctg cacctggcca
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781  gtacgcctc tatcttgctc atgacagtca taagcatga cgggtttctg gctgtggtgt
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901  tctgggcttt ggccatcgca ggggtagtgc ctctcgtcct caaggagcaa accatccagg
961  tgcccggtct caacatcact acctgtcatg atgtgctcaa tgaaccctg ctgaaaggct
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1081 ccacgggtctg ttatgtgtct atcatctgat gtcttagctc ttccgcagtt gccaaaccga
1141 gcaagaagtc ccgggctttg ttccgtgtcag ctgctgtttt ctgcatcttc atcatttgct
1201 tcggaccac aaacgtcctc ctgattgcgc attactcatt cctttctcac acttccacca
1261 cagaggctgc ctactttgcc tacctcctct gtgtctgtgt cagcagcata agctcgtgca
1321 tcgacccctc aattactat tacgttctct ctgagtggca gaggtacgtc tacagtatct

```

Fig. 1a

```

1381 tatgctgcaa agaaagtcc gatccagca gttataacag cagtgggcag ttgatggcaa
1441 gtaaaatgga tacctgctct agtaacctga ataacagcat atacaaaaag ctgttaactt
1501 aggaaaaggg actgctggga ggttaaaaag aaaagtatat aaagtgaat aacctgagga
1561 ttctattagt cccacccaa actttattga ttcacctcct aaaacaacag atgtacgact
1621 tgcatacctg ctthttatgg gagctgtcaa gcatgtattt ttgtcaatta ccagaaaagat
1681 aacaggacga gatgacggtg ttattccaag ggaatatatgc caatgctaca gtaataaatg
1741 aatgtcactt ctggatatag ctaggtgaca tatacatact tacatgtgtg tataatgtaga
1801 tgtatgcaca cacatatatt atttgcaatg cagtatagaa taggcacttt aaacactct
1861 tccccgcac ccagcaatt atgaaaaata tctctgattc cctgatttaa tatgcaaagt
1921 ctaggttggt agagtttagc cctgaacatt tcatgggtgtt catcaacagt gagagactcc
1981 atagtttggg ctgtaccac ttttgcaaat aagtgtattt tgaaattgtt tgacggcaag
2041 gtttaagtta ttaagaggta agacttagta ctatctgtgc gtagaagttc tagtgttttc
2101 aattttaaac atatccaagt ttgaattcct aaaattatgg aaacagatga aaagcctctg
2161 ttttgatatg gtagtatatt ttacatattt acacactgta cacataagcc aaaactgagc
2221 ataagtcctc tagtgaatgt aggcaggcct tcagagtagg ctaggtcctga gagctgcatg
2281 tgtccgcccc cgatggagga ctccaggcag cagacacatg ccaggggccat gtcagacaca
2341 gattggccag aaacctcct gctgagcctc acagcagtga gactggggcc actacatttg
2401 ctccatcctc ctgggattgg ctgtgaactg atcatgttta tgagaaactg gcaaaagcaga
2461 atgtgatata ctaggaggta atgaccatga aagacttctc taccatctt aaaaacaacg
2521 aaagaaggca tggacttctg gatgcccatc cactgggtgt aaacacatct agtagttgtt
2581 ctgaaatgtc agttctgata tggaagcacc cattatgcgc tgtggccact ccaataggtg
2641 ctgagtgtac agagtggaaat aagacagaga cctgccctca agagcaaagt agatcatgca

```

Fig. 1a (Cont.)

```

2701 tagagtgtga tgtatgtgta ataaatatgt ttcacacaaa caaggcctgt cagctaaaga
2761 agtttgaaca tttgggttac tatttcttgt ggtataaact taatgaaac aatgcagtac
2821 aggacatata ttttttaaaa taagtctgat ttaattgggc actatttatt tacaatatgtt
2881 ttgctcaata gattgctcaa atcagggttt cttttaagaa tcaatcatgt cagtctgctt
2941 agaaataaca gaagaaaata gaattgacat tgaaatctag gaaaattatt ctataatttc
3001 catttactta agacttaatg agactttaaa agcattttt aacctcctaa gtatcaagta
3061 tagaaaatct tcatggaatt cacaagtaa tttggaaatt aggttgaaac atatctctta
3121 tcttacgaaa aatggtagc attttaaca aatagaaag ttgcaaggca aatgtttatt
3181 taaaagagca ggccaggcgc ggtggctcac gcctgtaac gctaacacgg tgaaccctg
3241 ggcggtgga tcacgaggtc aggagatcga gaccatcctg gctaacacgg tgaaccctg
3301 ctctactaaa aatgcaaaaa aattagccg ggcgtggtgg caggcacctg tagtcccagc
3361 tactcgggag gctgaggcag gagactggcg tgaaccagg aggcggacct tgtagtgagc
3421 cgagatcgcg ccactgtgct ccagcctggg caacagagca agactccatc tcaaaaaaaa

```

Fig. 1a (Cont.)

MGPRRLLLVAACFSLCGPLLSARTRARRPESKATNATLD
PRSFLLRNPNDKYEPFWEDEEEKNESGLTEYRLVSINKSS
PLQKQLPAFISEDASGYLTSSWLTFLVPSVYTG VFVWSL
PLNIMAIVVFILKMKVKKPAVVYMLHLATADVLFVSVLPFK
ISYYFSGSDWQFGSEL CRFVTAAFYCNMYASILLMTVISI
DRFLAVVYPMQSLSWRTLGRASFTCLAIWALAIAGVVPL
VLKEQTIQVPGLNITTCHDVLNETLLEGYYAAYFSAFSAV
FFFVPLIISTVCYVSIIRCLSSSAVANRSKKSRAFLSAAV
FCIFIICFGPTNVLLIAHYSFLSHTSTTEAAYFAYLLCVCVS
SISSCIDPLIYYYASSECCQRYVYSILCCKESSDPSSYNSS
GQLMASKMDTCSSNLNNSIYKKLLTZ

Fig. 1b

5'-CGCCGAGGGTCGCTTGGACCCTGATCTTACCCGTGGGCACCCCTGCGCTCTGCGCTGCC
GCGAAGACCGGCTCCCCGACCCCGCAGAAAGTCAGGAGAGAGGGTGAAGCGGAGCAGCCCCGA
GGCGGGCAGCCTCCCCGGAGCAGCGCCCGCAGAGCCCGGGACAATGGGGCCCGCGCGGGC
TGCTGTGTGGCCGCTGCTTCAAGTCTGTGCGGCCCGCTGTTGTCTGCCCCGCACCCCGGG
CCCGCAGGCCAGAAATCAAAAGCAACAAATGCCACCTTAGATCCCCGGTCAATTCTTCTCA
GGAACCCCAATGATAAATATGAACCATTTTGGAGGATGAGGAGAAATGAAAAGTGGGT
TAACTGAATACAGATTAGTCTCCATCAATAAAAGCAGTCCTCTTCAAAACAACCTTCCTG
CATTCACTCAGAAAGATGCCCTCCGGATAATTGACCAAGCTCCTGGCTGACACTCTTTGTCC
CATCTGTGTACACCGGAGTGTGTGTAGTCAGCCTCCCACTAAACATCATGGGCCATCGTTG
TGTTCAATCCTG-3'

Fig. 2

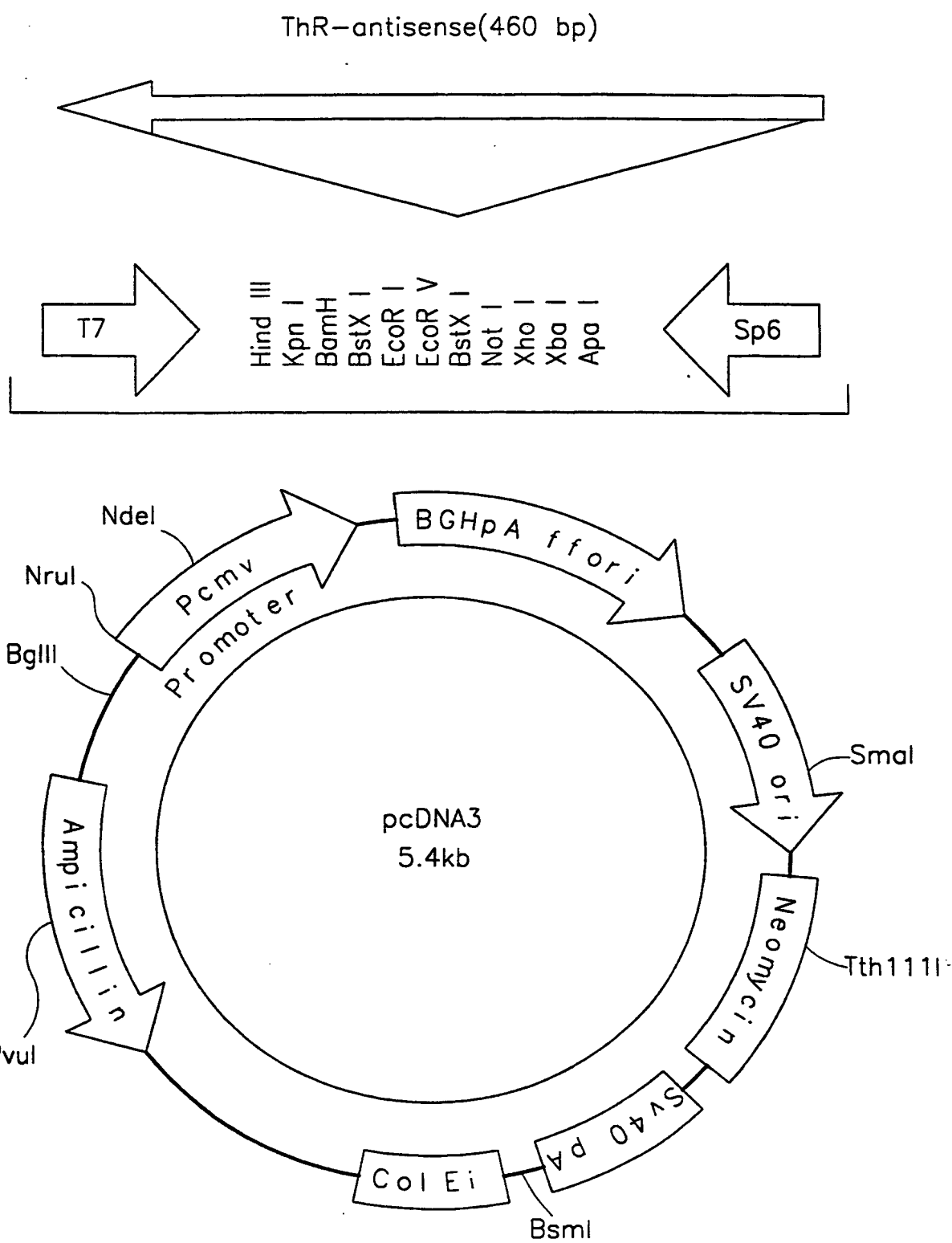


FIG.3



FIG.4

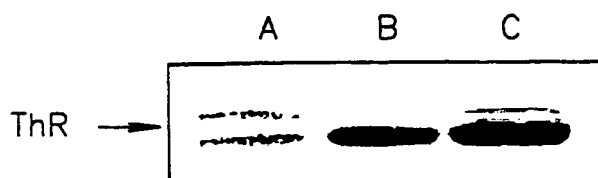
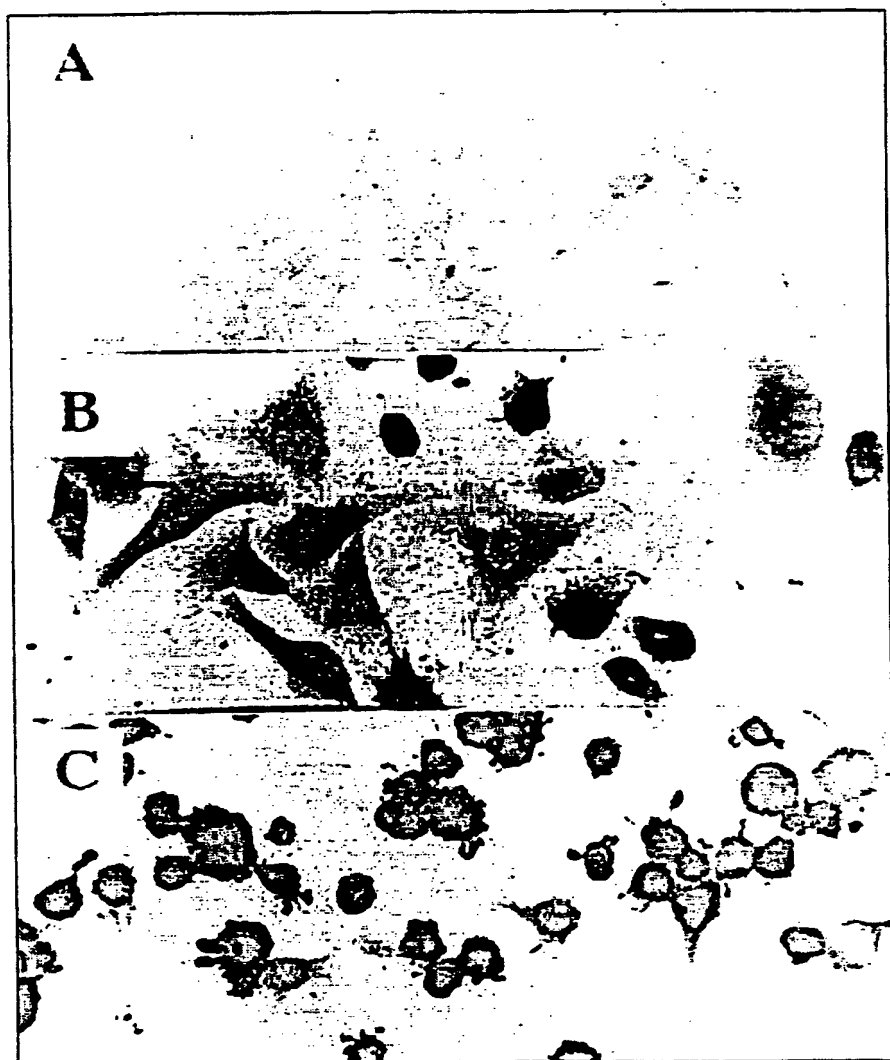


FIG.5

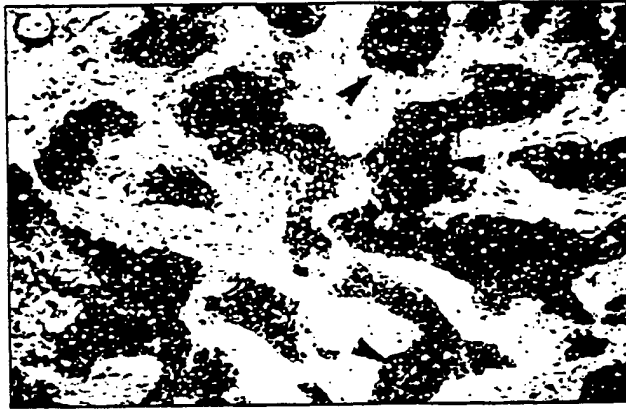


FIG. 6C

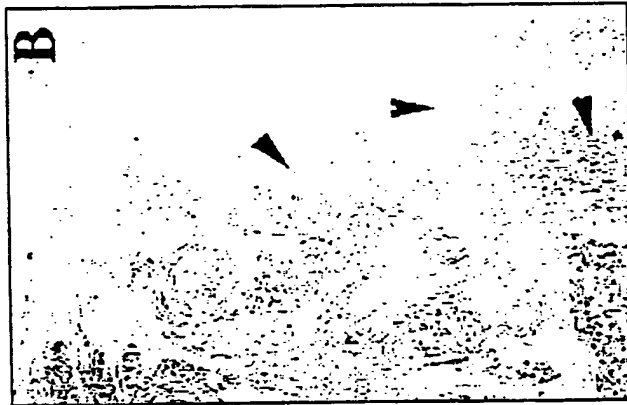


FIG. 6B

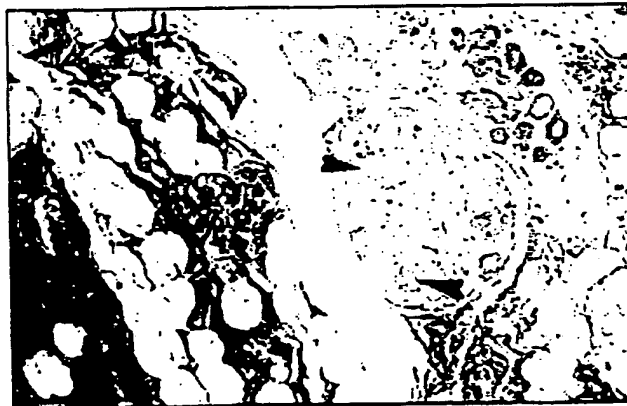


FIG. 6A

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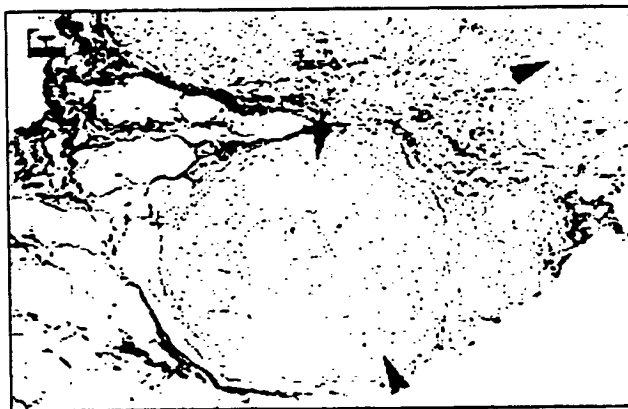


FIG. 6F



FIG. 6E

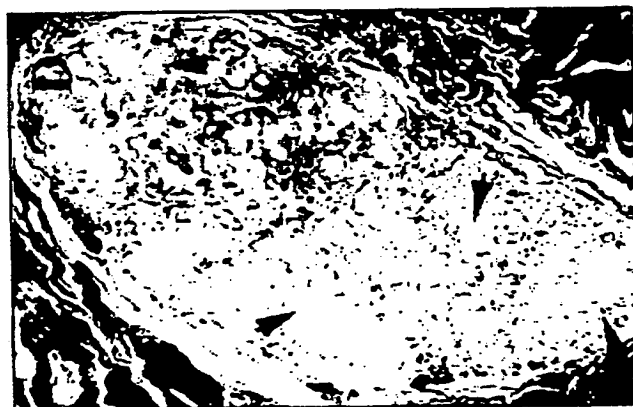


FIG. 6D



FIG. 6I

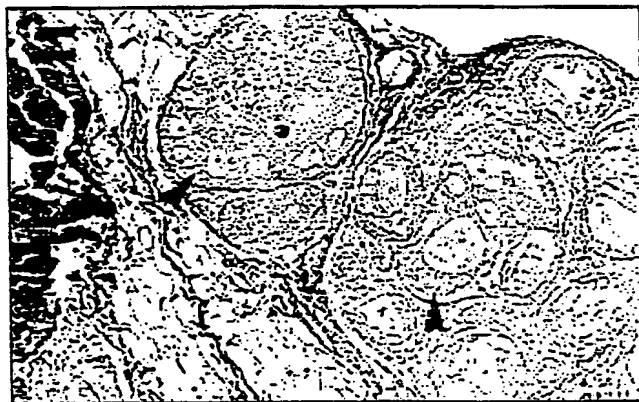


FIG. 6H

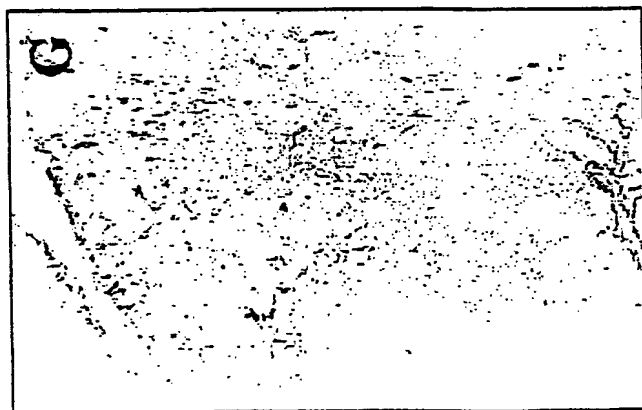


FIG. 6G

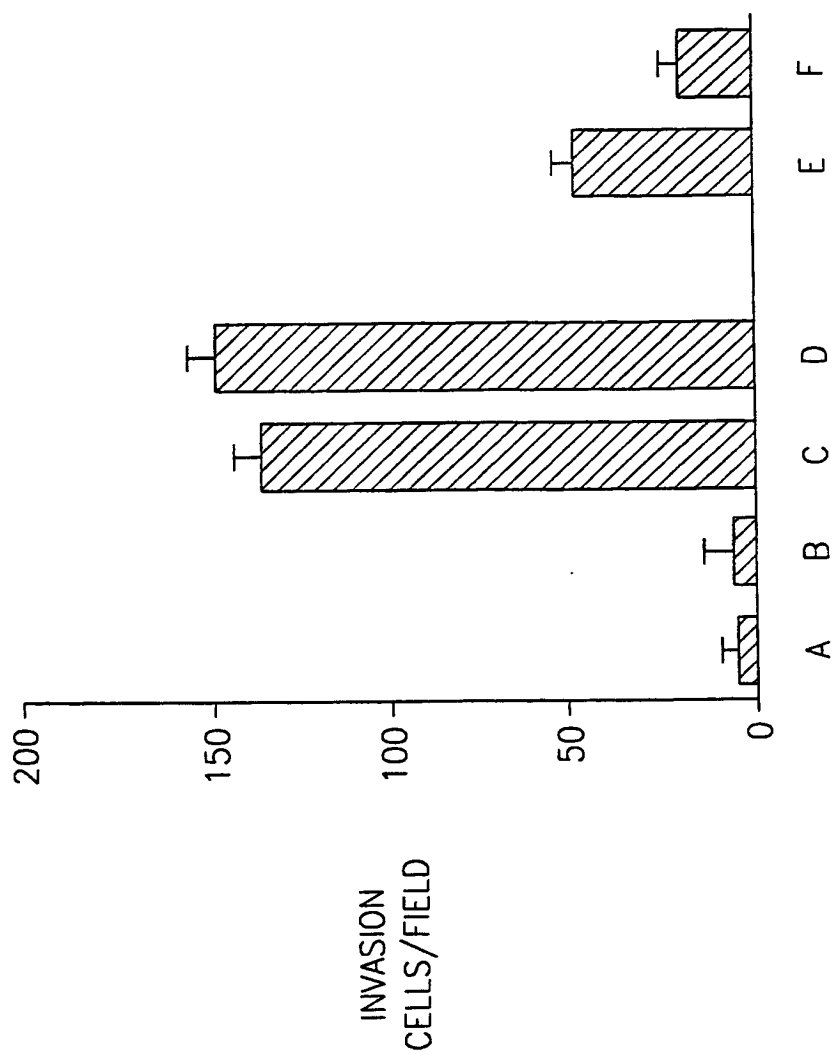


FIG. 7

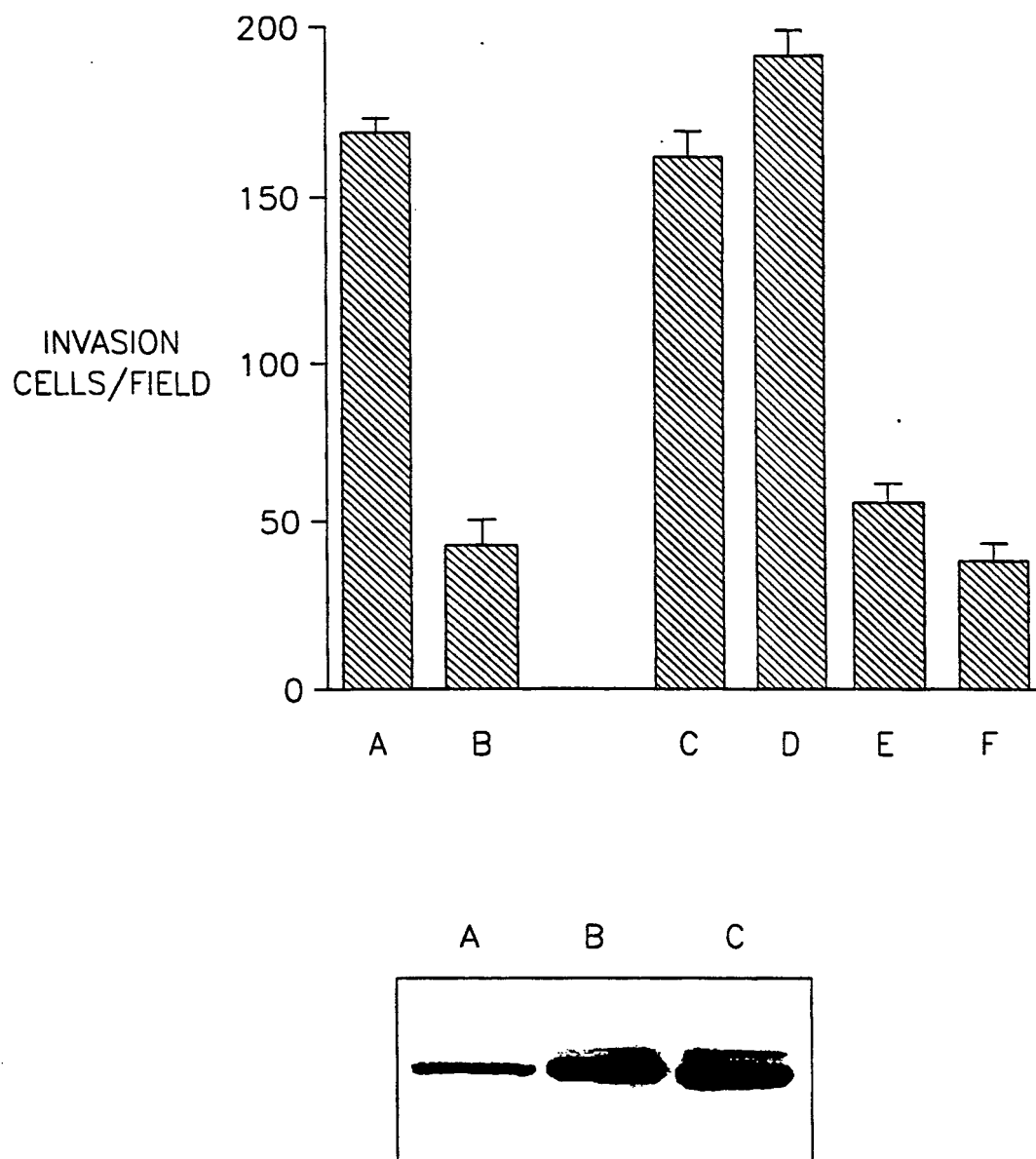


FIG.8

```

1  aaatgaata aatgaatgta ctttcatttg acaaaaccag tgttactgct gaaacattta
61  tttctgtaat gacccttgct ttccctttctt gtacaggaac caatagatcc tctaaaggaa
121  gaagccttat tggtaagggt gatggcacat cccacgtcac tggaaaagga gttacagttg
181  aaacagtctt ttctgtggat gatttttctg catctgtcct cactggaaa ctagccactg
241  tcttccttcc aattgtctac acaattgtgt ttgtggtggg tttgccaagt aacggcatgg
301  cctgtgggt ctttcttttc cgaactaaga agaagcacc cgtgtgatt tacatggcca
361  atctggcctt ggctgacct ctctctgtca tctggttccc cttgaagatt gcctatcaca
421  tacatggcaa caactggatt tatggggaag ctctttgtaa tgtcttatt ggcttttctt
481  atggcaacat gtactgttcc attctcttca tgacctgcct cagtgtgcag aggtattggg
541  tcatcgtgaa cccatgggg cactccagga agaaggcaaa cattgccatt ggcattctcc
601  tggcaatatg gctgctgatt ctgctggtea ccatccctt gtatgtctg aagcagacca
661  tcttcattcc tgcctgaac atcagacct ctgctgatgt ttgtccctgag cagctcttgg
721  tgggagacat gttcaattac ttctctctc tggccattgg ggtcttctg ttccagcctt
781  tctcacagc ctctgcctat gtgctgatga tcagaatgct gcgatcttct gccatggatg
841  aaactcaga gaagaaaagg aagagggcca tcaaaactcat tgtcactgtc ctggccatgt
901  acctgatctg ctctactcct agtaacctc tgcttggtgt gcattatttt ctgattaaga
961  gccagggcca gagccatgtc tatgccctgt acattgtagc cctctgcctc tctaccctta
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1261  atgttatgag gacgtgtctg ttatttctt

```

Fig. 9

```

1  cggcacgagc aaggacgagt cccgtgccac acagtccagg ctggcagagt tctcagcttt
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121 aacatccctg agccgggtct caggacatca agatgaaaat ccttatcttg gttgcagctg
181 ggctgctgtt tctgccagtc actgtttgcc aaagtggcat aaatgtttca gacaactcag
241 caaagccaac cttaactatt aagagtttta atgggggtcc ccaaaatacc tttgaagaat
301 tcccactttc tgacatagag ggctggacag gagccaccac aactataaaa gcggagtgtc
361 ccgaggacag tatttcaact ctccacgtga ataatgctac cataggatac ctgagaagt
421 ccttaagtac ccaagtgata cctgccatct atatcctgct gtttgtggtt ggtgtaccat
481 ccaacatcgt gacctgtgg aaactctcct taaggaccaa atccatcagt ctggtcatct
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1681 atacatgtcc ccttccctcc tgtgagcggc gtccgcagac tgggaggttg tccactaccg
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2281 gattcaacca accacagacc caaaacactt gaaaaacctt gtatgagctg aaaacgaaga
2341 gttctatttt tcattactcc nttaaataata ntgataataa ataataataa ataaaaaaa
2401 aaaaaaaaaa

```

Fig 10

```

1  ctcccacggg ctggctggca agcgccctcg gtgggtctgc gggggcaggg gcagccctcc
61  tggtttatct ccaccggcgc gatctgctcg tccgcctcgg ctccagaagc tggggctcag
121 ggtccggcga ggcaggaagc ctgagggcac agcccagagc agcctgagtg cagtcagtgtg
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361 gctcccgga agctcacggg cactgctct gggctgggtg ccacaccggc tggtgcccg
421 cctctatggg ctggtctcgg tgggtgggct gccggccaat gggctggcg tgtgggtgct
481 ggccacgcag gcacctcggc tgcctccac calgtgtctg atgaacctcg cgactgcga
541 cctcctgtg gccctggcg tgcctcccg gatgcctac cactgtcgtg gccagcgtg
601 gcccttcgg gaggcgcct gccgcctggc caggccgca ctctatggc acatgtatgg
661 ctcagtgtcg ctgctggcg cgtcagcct ggatcgtac ctggccctgg tgcacccgct
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781 catggcgcc gccctggcac tgcctctgac actgcagcg cagacctcc ggctggcgcg
841 ctccgatcg gtgctctgcc atgacgcgt gccctggac gcacaggcct cccactggca
901 accggcctc acctgcctgg cgctgttggg ctgttctcg cccctgctgg ccatgtctgt
961 gtgctacgg gccaccctgc acacgtggc ggccagcggc cggcgctag gccacgcgt
1021 gaggtgacc gcagtgtgc tggcctcgc cgtggcctc ttcgtgcca gcaacctgct
1081 gctgtgtctg cattactcg accgagccc cagcgcctgg ggcaacctct atggtgccta
1141 cgtgcccagc ctggcgctga gcacctcaa cagctgcgtg gatcccttca tctactata

```

Fig. 11a

1201 cgtgtcggcc gatttcaggg acaaggtgcg ggcagggctc ttccaacggt cgcgggggga
 1261 caccgtggcc tccaaggcct ctgcggaagg ggcagccgg ggcatgggca ccactctc
 1321 ttgtctccag tgacacaaag tggggaaggc tgtactgggt cgaacagggc ccttcccc
 1381 acttcacgic ctctcggga cctcagaatg tgacctatt tggaatatagg gttgtacaa
 1441 ctgtcactag cggagggtcac ttggagaag ggtgggcctt acatccagtg tgggtgggtg
 1501 cctcataaga taaggagagg ccaggccctg tggctacgc ctgtaatccc agcactttaa
 1561 gaggccaagg cggatggatc acttgagccc aggagttcaa caccagcccg agcaacatgg
 1621 taaaacccca tctctaccaa aaatacaaaa attagctggg ctgtgtggct ggcgcctgta
 1681 atccagcta ctcaggagac tgaggcagaa ggtatgcctg aacctgggag gcagagggtg
 1741 cagttagccg agattgcgc acttgacccc agcctgcgtg acagagagcc tgtctctaaa
 1801 ttaattaatt aattaatta attcaattt aaaaagacga aaagtgcag ccagggtgcag
 1861 tggctcacgc ctataatc agcactcgg aggcccaaga tggaggattg ctggaagcca
 1921 ggagtttggg accagccctg gcaacatagg gggatcccat ctctacacac aaaaaaattt
 1981 ttaatatgaac caggcattgt ggcatgcgc tatagtcca gccactcaag aggcacagggc
 2041 gggaggatca ctgagccctg ggagggtgtg ttgcagtga gctatgattg taccactgca
 2101 ctccagcctg ggcaacagag caagaccctg tctcaaaaat aaacaaacta aaattaaaaa
 2161 aagaagacga gagatagtgg gtgtgtgtgg tcacacctgc aatcccagca ctgtggaagg
 2221 ccgaggtggg cagatcatct gaggccagga gttcaagacc agcctggcta acatggtgaa

Fig. 11a (Cont.)

2281 atcctatctc taccaaaaat acaaaaatta gccaggcgtg gtggtgggca cctgtactgg
2341 ggaggtgccc acccagctac tggggaggct ggtcaggag aatcgcttga acctggggagg
2401 cggagggtgc ggtcagctga gatggtgcca ctgcactcca gcctgggcca aagagcgact
2461 ctgtctcaa aaaaaagaga agaggagagg acacagagac acacagagaa gaaagccaatg
2521 tggcggcaga ggcagagatg ggagtatgc ggacggacac aaactaaggg atgccacgat
2581 gccaaagaca gccaacagcc accagcagcc aggagacagg cctgggacgg gctctccctc
2641 acagcctcca gagggaacca gccctgccac caccttgacc ctggacttct ggccctgcaga
2701 actgtgagac aataaactct cattgttta agctgcctgg catgtggcac ttgtcaggg
2761 cagcccagga atctgaaca ggaacaaact ctgcttcctg ggcccctgcca gcatctcgg
2821 ctcggccttc tgggctggat gcagcccacg acgcactggt gtcgtagatg gggctggagc
2881 tggggctggg gctgcattcc ctggagactc actgcaagt cctgcccagg aggctgaggg
2941 caccctatcc tcagtgtcca atgctgtggc cccaccaggc ccagagccctg gttggccatt
3001 ctcattgccc ccagctctg gctttggggt gtccttgag caaccagaat agcaccacca
3061 actctgctcc caaaaacca tcactagcac ggctcagcct ctgctatcc cctgactgct
3121 ggggacctc gccctccctc ctctcaccg caggctgac cttctttca cttctgtca
3181 atgtcaccag ggataagggt ggacaatggg ggggtggggt ggacagtgtg tgcgtggggg
3241 ttcgggtgct gcagacctgg aactcccttc tgcaggatg ttggcagccg gttgtaagcc
3301 ttgcacggga cagaccacac ccaccgcaac ctatccct cagcactaac cacatccact

Fig. 11a (Cont.)

3361 ctcaaccccg tcccttcgc acigaccaca ccaccccgt tggccccgc ccccgcaact
3421 gaacactccc gccctcaacc cgcaccctc cgcactacc tccccctgc cgctcgaccc
3481 cgccctcacc acacigacca cctcaacc attgcgcca gtccccacca cagtgaaccac
3541 accctcactg gctcggccct gcccccagta tactgacct tccccagcca ctcccttcc
3601 gcactacca ctccccagc cagccccctc cccgtgacc gctctccag cccgcctcc
3661 cccgtacagg cagagcgccc gccacctct atgctcggtt ctctgactt tacgttgccc
3721 cctcctctgc caagcccca gggagccct ccttggcgtc cgagggtgg agtcggggtg
3781 tggcaggccg cgttggggg cgcagtggc tcgcgcact caccgggccc cgggagggg
3841 gcgcgctcca ctctgttga cgcgggtccg gcgcacagtt cccgggagag tggctgtgc
3901 gtctgacgt tgtagaagcg agtggcctcg aaggtacgg gacgagggtg gcgggtgacc
3961 aagtgcaggc gcgacgggtc agggaccggg cgggcccggg ggtgcgggag cgcgggccta
4021 cggggtcgt agtagtcgt cacggagact ggcagcgccg acgtcctgcc caccacgcac
4081 tccgggagag cacggaaccg cagcacgtc aggcaccggc tggggatctg tggggcagcg
4141 gcgggcgcag gctcgacccg ggcaggagg cccggggcg tgagctcagg ccagaaactg
4201 gctgatttca gggataccca ggacgctga aacacagaag aaacgtgac ccatttctt
4261 ttttctttt acttttctt tttttttt ttctgagac agagtctgc gctgtgccc
4321 aggcctggagt gcagtggcgt gatctggct cactgcaagc tcggcctctt gggttcaaat
4381 gattctccg cctcagcctc ccaagtagct gggataacag gcgcccacca ccgacccctg

Fig. 11a (Cont.)

4441 ctaattttt gtattttga tcaagacgga gtttcacat gttggccagg ctggtctcca
4501 actcctgccc tcaagtgatc cgctcggtc caattttta ttcttgggt ccttccatcc
4561 cactgggaaa acgtctcagg tggcctctga aacaccactc ctttttgtgt gtgtgcacgc
4621 atggctgagc atgtgtgggt gggagtcagc acattcacga tactgtgcaa tcatcacctc
4681 tgctctagta caggacgggt tctttctccc ccaaagaac cccatcgcca tcagcactca
4741 ctcccactc cccagcccc tggcaaccac aaatcttcc aactctacgg atttgccctgt
4801 tctgggcatt tcatgtcaat ggaatcatgt actctgtgaa aaaaaaaaaa aaaaaaaaaa
4861 aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaa

Fig. 11a (Cont.)

MWGRLLWPLVLGFSLSGGTQTPSVYDESGSTGGDDSTPSILP
APRGYPGQVCANDSDTLELPDSSRALLLGWVPTRLVPALYGLVLVVGLPANGLALWVL
ATQAPRLPSTMLLMNLATADLLALALPPRIAYHLRGQRWPFGEAACRLATAALYGHM
YGSVLLAAVSLDRYLALVHPLRARALRGRRALGLCMAAWLMAAALALPLTLQRQTF
RLARSDRVLCHDALPLDAQASHWQPAFTCLALLGCFLPLLAMLLCYGATLHTLAASGR
RYGHALRLTAVVLA SAVAFFVPSNLLLLLHYSDPSPSAWGNLYGAYVPSLALSTLNSC
VDPFIYYVSAEFRDKVRAGLFQRSPGDTVASKASAEGGSRGMGTHSSLLQ

Fig. 11b



FIG. 12C



FIG. 12B



FIG. 12A

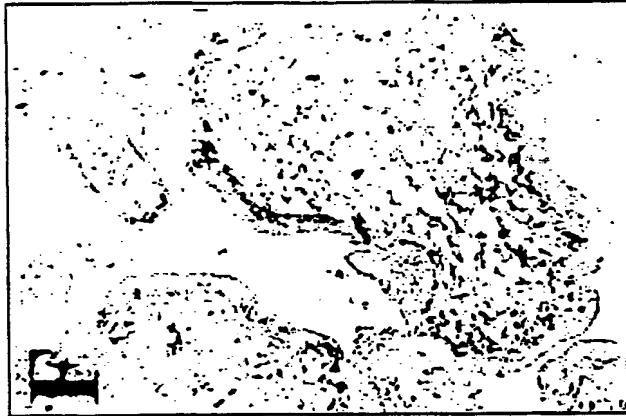


FIG. 12F

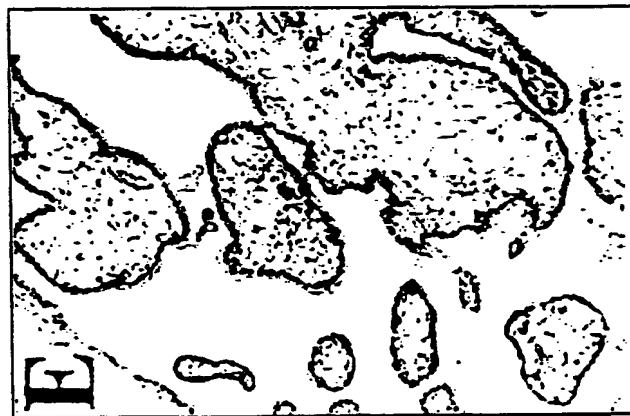


FIG. 12E



FIG. 12D

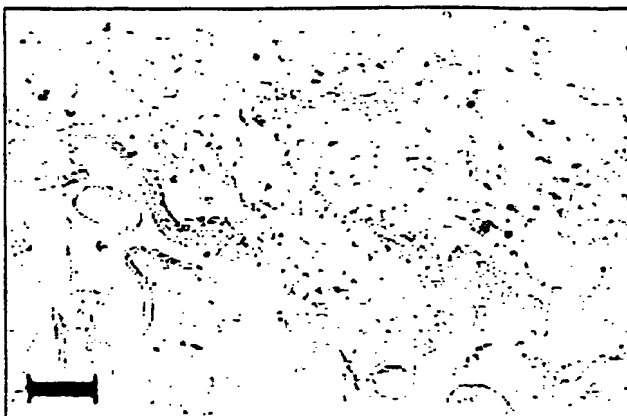


FIG.12I

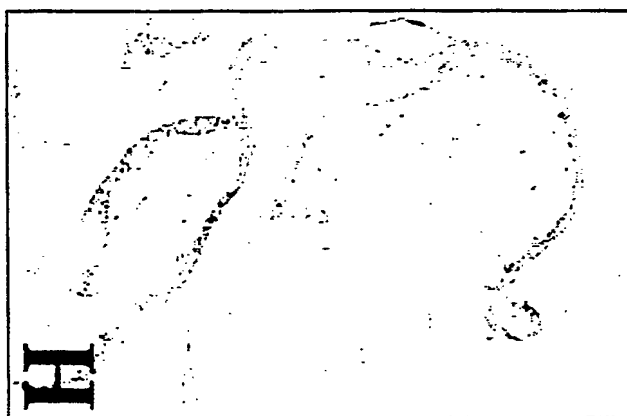


FIG.12H



FIG.12G

INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :C12N 15/12; A61K 37/02

US CL :536/23.5; 435/69.1, 325, 320.1; 514/13

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 536/23.5; 435/69.1, 325, 320.1; 514/13

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Chemical Abstracts

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,352,664 A (CARNEY et al) 04 October 1994, see entire document.	1-19
A,E	US 5,892,014 A (COUGHLIN et al) 06 April 1999, see entire document.	1-19

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

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Date of the actual completion of the international search

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